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Late Wisconsinan and Holocene Fauna from Smith Creek Canyon, Snake Range, Nevada

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Abstract. During the late Pleistocene, montane glaciers in the Snake Range, eastern Nevada reached an elevation as low as 2900 m and pluvial Lake Bonneville rose to approximately 1580 m, only 130 m below the entrance of the east-facing Smith Creek Canyon. It is not known whether the two events coincided. Packrat midden macrofossils indicate that bristlecone pine (*Pinus longaeva*), limber pine (*P. flexilis*), and other subalpine taxa dominated the plant communities in Smith Creek Canyon through the late Wisconsinan. We report here 2 fish, 4 anurans, 9 lizards, 8 snakes, and 15 small mammals recovered from 15 packrat middens and a pollen profile from cave fill. This assemblage adds 15 amphibians and reptiles and 7 mammals to the approximately 46 terrestrial animals previously known from the late Pleistocene and early Holocene of the canyon. Dung pellets of the locally extirpated pika (*Ochotona* cf. *princeps*) were found in five packrat middens. A single tooth of the heather vole (*Phenacomys* cf. *intermedius*) from Smith Creek Cave is the first late Pleistocene record for this genus in the Great Basin. We review and update the late Pleistocene and Holocene fauna from 4 caves and 2 shelters in Smith Creek Canyon.

Introduction

The Snake Range of White Pine County, eastern Nevada, is a north–south trending mountain 80 km long. Smith Creek Canyon, a deep canyon on the eastern face of this Great Basin range, opens onto the Lake Bonneville playa in the Snake Valley of Utah. During the late Pleistocene, montane glaciers reached elevations as low as 2900 m in the Snake Range (Drewes 1958), and pluvial Lake Bonneville rose to a level of approximately 1580 m, only 130 m below the entrance of Smith Creek Canyon. If the late Wisconsinan glacial maximum coincided with the high stand of Lake Bonneville, biotic communities in this canyon would have been restricted to an elevational range of less than 1310 m (Fig. 1).

Fossil localities.—Late Pleistocene vertebrate fossils from Smith Creek Canyon, specifically Smith Creek Cave, were reported by M. Harrington (1934) from the Southwest Museum and by others since. In 1955, T. E. Downs and associates from the Natural History Museum of Los Angeles County (LACM), California, screened some of the cave sediments. Field notes of the LACM indicate that the cave contained little or no stratification (Brattstrom 1976). Howard (1935, 1952) described a new species of extinct eagle (*Spizaetus willetti*) and a teratorn (*Teratornis incredibilis*) and listed the Smith Creek Cave avifauna, unfortunately giving the stratigraphic associations only as from the older deposits of the lower levels. Stock (1936) described a new species of extinct mountain goat (*Oreamnos harringtoni*), but again did not discuss placement within the stratigraphic sequence. Brattstrom (1958, 1976) reported amphibians and reptiles from the cave sediments and Goodrich (1965) updated the list of the entire fauna (amphibians, reptiles, birds, and mammals); again the stratigraphy and temporal associations were only scantily discussed.

Bryan (1979*a*) made further excavations in the cave in search of evidence for Early Man and for the first time described the stratigraphy within a portion of the cave.

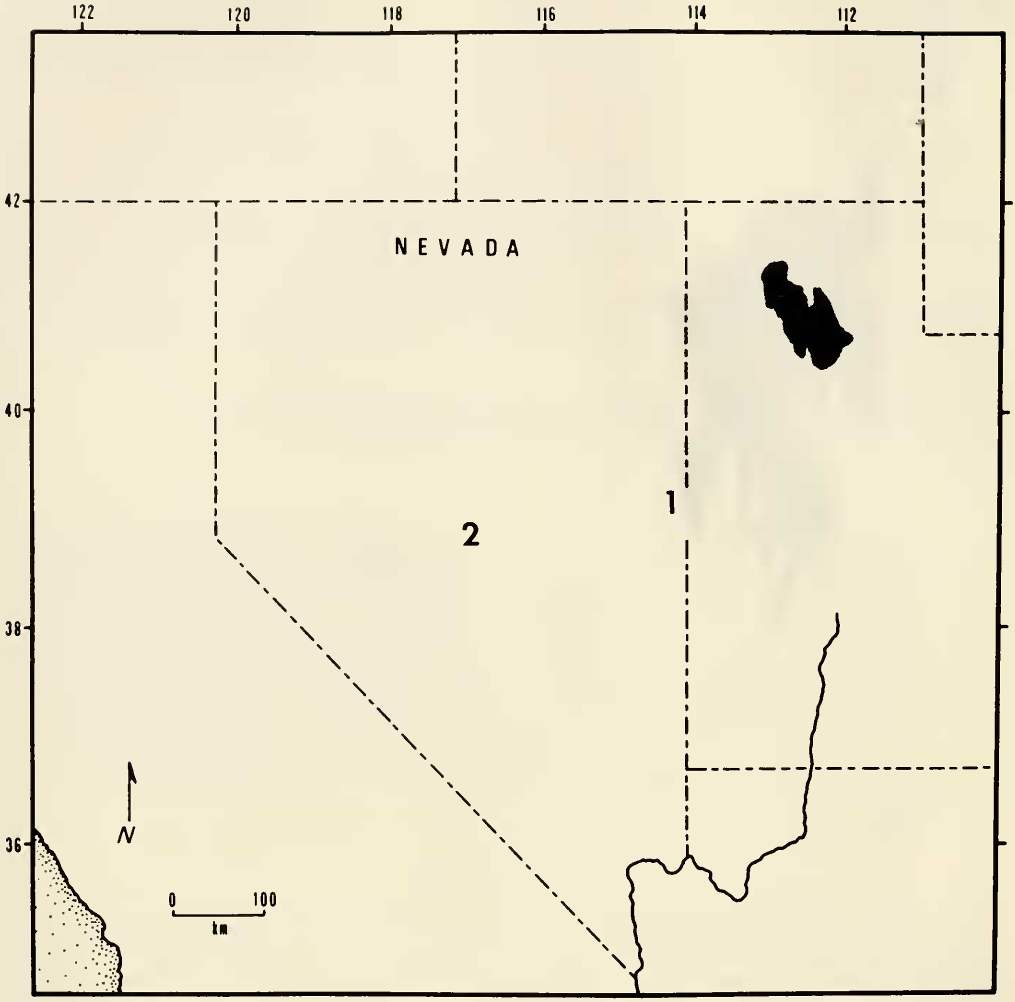

FIGURE 1. Map of Nevada and bordering states showing Smith Creek Canyon (1) and Gatecliff Shelter (2) along with Great Salt Lake (black) and Lake Bonneville (stippled) at the 1580 m elevation.

Miller (1979) identified the mammalian fauna recovered during Bryan's excavations, providing another updated listing of the fauna; some stratigraphic associations were given. Both Bryan (1979*a*) and Miller (1979) emphasized the deposits and fauna associated with Man, those units dating less than 11 500 B.P. Thus no comprehensive stratigraphic analysis of the fauna has been published.

In 1977 and 1978 we visited Smith Creek Canyon to study fossil packrat (*Neotoma*) middens and to collect a pollen profile from the Smith Creek Cave sediments. Plant remains from some of these middens are discussed in a previous report (Thompson 1979), and other assemblages are still being analyzed (RST). The packrat midden fossils document that bristlecone pine (*Pinus longaeva*), limber pine (*P. flexilis*), and other subalpine taxa dominated the plant communities in Smith Creek Canyon throughout the late Wisconsinan. The Smith Creek Cave pollen profile provided little paleoenvironmental information and could not be dated directly. In this report we describe the fish, amphibians, reptiles, and mammals recovered from 15 packrat middens from Smith Creek Canyon and in association with the pollen profile, and the herpetofauna recovered by Bryan (1979*a*, Miller 1979) in his excavation in Smith Creek Cave. We also review the entire local fauna recovered from all archaeological and paleontological investigations in Smith Creek Canyon and attempt to place these records in the correct paleoenvironmental and chronological context.

Local setting.—The lower concourse of Smith Creek Canyon is a steep-walled east–west trending canyon incised into Paleozoic limestone. In this part of the canyon there are numerous caves, including those described below in which we have found our fossil materials. The upper reaches of Smith Creek Canyon are lined with other Paleozoic sedimentary rocks and Mesozoic intrusives. We have not located any caves or fossil packrat middens in this area. The intermittent waters of Smith Creek are primarily derived from the elevated plateau surrounding Mount Moriah (3673 m).

Although the vegetation in Smith Creek Canyon is broadly divided into elevational zones, the major slope and aspect contrasts between the north and south facing slopes create numerous microenvironments for plants of higher and lower elevations. At the canyon entrance the plant community is dominated by shadscale (*Atriplex confertifolia*) and other xerophytes, including spiny hopsage (*Grayia spinosa*), greasewood (*Sarcobatus vermiculatus*), rabbitbush (*Chrysothamnus nauseosus*), Mormon tea (*Ephedra nevadensis*), horsebrush (*Tetradymia axillaris*), Harriman yucca (*Yucca harrimaniae*), and bud-sage (*Artemisia spinescens*). These same taxa are dominant in the Snake Valley to the east and also are common on xeric slopes throughout Smith Creek Canyon.

Sagebrush (*Artemisia tridentata, A. nova*) occurs both in nearly pure stands in the canyon bottom and as a common understory element in the pinyon-juniper woodlands and forested communities. Utah juniper (*Juniperus osteosperma*) and single needle pinyon (*Pinus monophylla*) occur throughout the limestone walled part of the canyon and form denser stands on the north facing slopes and on alluvium. Little leaf mountain mahogany (*Cercocarpus intricatus*), greasebush (*Forsellesia nevadensis*), skunkbush (*Rhus trilobata*), and joint-fir (*Ephedra viridis*) are common in the pinyon-juniper woodland and are often dominant on xeric slopes and on limestone substrates.

Montane and subalpine conifers, including white fir (*Abies concolor*), Douglas fir (*Pseudotsuga menziesii*), Engelmann spruce (*Picea engelmannii*), ponderosa pine (*Pinus ponderosa*), limber pine, and bristlecone pine, are present at relatively low elevations in mesic niches on the north facing slope and along the upper concourse of Smith Creek. Other common riparian plants include narrowleaf cottonwood (*Populus angustifolia*), willows (*Salix* spp.), water birch (*Betula occidentalis*), chokecherry (*Prunus virginiana*), Rocky Mountain maple (*Acer glabrum*), Rocky Mountain juniper (*Juniperus scopulorum*), and wild rose (*Rosa woodsii*). The higher elevations of the northern Snake Range support groves of quaking aspen (*Populus tremuloides*) and stands of bristlecone pine and limber pine on rocky outcrops.

Although the fossil localities we investigated occur in a narrow elevational range (1860 m to 2060 m), the variations in slope and aspect at these sites place them in different environmental settings (Table 1). Smith Creek Cave (1950 m elev.) and Ladder Cave (2060 m elev.) are on a steep south facing slope at the entrance to the canyon and are surrounded by a xeric pinyon-juniper woodland with an abundance of xerophytic plants (*see* Thompson 1979). Streamview Shelter is on a protected north facing slope near the canyon bottom (1860 m elev.), and Council Hall Cave is higher (2040 m elev.) on the same slope. These two sites are in a relatively dense pinyon-juniper woodland, with fewer xerophytes than on the opposing slope. Montane and subalpine conifers occur in protected niches near both Council Hall Cave and Streamview Shelter. Amy's Shelter and the Kachina Cave are in the bottom of the canyon by the creek. These two sites probably were buried by alluvium during the last full-glacial, only to be exposed during the latest phases of the late glacial or early Holocene.

Methods

The Smith Creek Canyon localities included within this report are Smith Creek, Ladder, Council Hall, and Kachina caves, Amy's Shelter and the packrat midden rockshelter we named Streamview.

TABLE 1. Paleontological and archaeological sites in Smith Creek Canyon, Snake Range, and the adjacent Snake Valley, Nevada, that are discussed in text.

Locality	Slope	Elevation	Type of deposit	Age range (yr B.P.)	Present status
Smith Creek Cave	South-facing	1950 m	Archaeological and non-archaeological cave sediments; 4 packrat middens	≥12 500 to 1000	Relatively xeric site, sparse pinyon-juniper woodland, active talus formation, high above canyon bottom
Ladder Cave	South-facing	2060 m	6 packrat middens	27 000 to 11 000	Relatively xeric site, sparse pinyon-juniper woodland, active talus formation, high above canyon bottom
Amy's Rockshelter	North-facing	1740 m	Archaeological cave sediments	5000 to 1500	In canyon bottom near entrance, relatively arid, scattered juniper with sagebrush-shadscale shrub
Streamview Rockshelter	North-facing	1860 m	3 packrat middens	17 000 to 6500	Ca. 15 m above canyon bottom, pinyon-juniper
Kachina Cave	North-facing	1770 m	Archaeological cave sediments	ca. 4500 to present	Along streamside of intermittent Smith Creek, pinyon-juniper and riparian vegetation
Council Hall Cave	North-facing	2040 m	Cave sediments; 2 packrat middens	24 000 to 4000	High above cayon bottom, relatively mesic site, pinyon-juniper with scattered subalpine conifers, little active talus formation
Garrison	North-facing	1640 m	Small overhang; 2 packrat middens	13 500 to 12 000	Small rock outcrop in the middle of Snake Valley, desertscrub, little active talus

Packrat middens.—All fossil packrat middens in this report were well-indurated with urine. To insure that stratigraphic units of different ages were not mixed during sampling, each midden was examined carefully prior to collection. Approximately two kilograms were removed from each stratigraphic unit and packaged in the field. In the laboratory approximately one kilogram of each unit was soaked in water until the cementing urine dissolved. The disaggregated samples were then washed through 20-mesh screens and oven dried. The fossils were hand-sorted, and after identification, plant remains were selected for radiocarbon dating and pretreated with 10% HCl in an ultrasonic cleaner. Radiocarbon dates from the packrat middens and the cave sediments (discussed below) are presented in Table 2.

Four of the 5 packrat middens recovered from Smith Creek Cave will be discussed. Radiocarbon dating of these middens indicates a time range from 11 650 ± 280 to 13 340 ± 430 yr B.P. (years before present, Table 2). Ladder Cave, a much smaller cave, is located immediately above Smith Creek Cave. We discuss 6 packrat middens from this cave, dating from 11 080 ± 115 to 27 280 ± 970 yr B.P. (Table 2). Two packrat middens from Council Hall Cave (Table 2) provided faunal remains of middle Holocene age (4220 ± 60 to 6120 ± 80 yr B.P.). Three middens reported from the Streamview locality date from the middle Holocene (6490 ± 190 yr B.P.), late glacial (11 010 ± 400 yr B.P.), and the end of the last full-glacial (17 350 ± 435 yr B.P.). Amy's Shelter is in the bottom of the canyon across the canyon from Smith Creek Cave. This site and Kachina Cave are included here to add the results of Miller's (1979) faunal study.

Smith Creek Cave stratigraphy.—The stratigraphy currently known from the

TABLE 2. Radiocarbon dated packrat middens and cave sediments from Smith Creek Canyon, Snake Range, Nevada (Thompson 1979, Thompson and Mead 1982). Associated plant material: A) Dung and/or unidentified plants; B) *Ephedra viridis*; C) *Juniperus communis*; D) *J. osteosperma*; E) *Picea engelmannii*; F) *Pinus flexilis*; G) *P. longaeva*; H) *P. monophylla*; I) *Artemisia* spp.; J) *Atriplex confertifolia*; K) *Cercocarpus intricatus*; L) *Chamaebatiaria millifolium*; M) *Chrysothamnus* sp.; N) *Foresellesia nevadensis*; O) *Ribes montigenum*; P) *Symphoricarpos* sp.; Q) *Rhus triolbata*.

Locality		Lab no.	Radiocarbon age (yr B.P.)	Material dated	Plant associates
Council Hall Cave (CHC)	1a	Wk-157	6120 ± 80	D	BKNHQ
	1b	Wk-158	4220 ± 60	D	BHKMQ
Ladder Cave (LC)	1	Wk-151	11 200 ± 200	G	DIKN
	2a	WK-152	27 280 ± 970	P	BDINO
	2b	A-2092	17 960 ± 110	A	GO
	3	Wk-154	13 230 ± 110	G	DILNO
	4	Wk-155	12 100 ± 150	G	IKNO
	6	Wk-156	11 080 ± 115	G	BDIKN
Smith Creek Cave (SCC)	1	Gx-5861	11 660 ± 245	A	FGKP
	3	Gx-5862	11 650 ± 280	G	MNP
	4	Gx-5863	12 235 ± 395	G	CIKN
	5	A-2094	13 340 ± 430	A	GILM
(Reddish-brown Silt: SCC Sed.)		Tx-1639	28 650 ± 760	(see text)	
Streamview Shelter (STV)	1	A-2095	11 010 ± 400	FG	INP
	2	Gx-5866	17 350 ± 435	G	CEJKN
	3	Gx-5867	6490 ± 190	D	BCGJK

northwestern sections of Smith Creek Cave was established from the excavation of Test Pits 2 and 3 (Bryan 1979*a*). The stratigraphic units established by Bryan will be followed in this report. Bryan recognized 3 stratigraphic "zones" in the rear of Smith Creek Cave, the lowest unit being the Cemented White Silt Zone. In the northwestern section of the cave, this unit was eroded away before the deposition of the second stratigraphic zone—the Reddish-brown Silt Zone. Bryan noted that the erosional disconformity between the Cemented White Silt Zone and the Reddish-brown Silt unit is near vertical. The reddish silt of the latter unit is believed to be of probable eolian deposition, although it is just as likely that water from a nearby ceiling conduit may have caused the erosion of the first stratigraphic unit and at least a partial deposition of the Reddish-brown Silt. This latter unit is very fossiliferous (partially a raptor accumulation) and is stained reddish-brown by the surrounding silt (dry 7/6 10YR, yellow; damp 5/8 7.5YR, strong brown, Munsell color; our observations). No organic remains, including charcoal, were observed in the Reddish-brown Silt by Bryan (1979*a*) or us. Permineralization has occurred with all of the red-stained bones (Miller 1979). Younger contaminating bones are white, not mineralized, and easily spotted.

Bryan (1979*a*) reported that "a sample of unidentified red-stained bone scrap [from Test Pit 2] yielded a collagen date of 28,650 ± 760 years B.P. (Tx-1639)." A discrepancy arises in that Valastro (1977) reported that the Tx-1639 ^{14}C date is from a charcoal sample from Test Pits 2 and 5; Test Pit 5 is at the mouth of the cave. We did not find charcoal in the unit in Test Pit 2. Because the red-stained bones in the Reddish-brown Silt in Test Pit 2 is permineralized with the loss of most bulk organic constituents (Miller 1979), we assume that the radiocarbon date from the unit is at best a very rough estimate of its true age and that the material dated was probably bone scraps, not charcoal. Further radiocarbon dating of this unit is in order.

Bryan indicated probable temporal correlations between the Reddish-brown Silt and the Laminated Pink Silt and Rubble Zone recognized in the excavation of the deposit at the mouth of the cave. Unlike the Reddish-brown Silt, this middle unit at the cave entrance rarely contains bones (Bryan 1979*a*). Although no radiometric dates were obtained from the Laminated Pink Silt and Rubble Zone, a ^{14}C date of 12 600 ± 170 B.P. (A-1565) was obtained at the lower boundary of the above unit—Bristlecone

TABLE 3. Wisconsinan and early Holocene fish, amphibians, and reptiles from Smith Creek Canyon. G) = previously reported by Goodrich (1965). B) = previously reported by Brattstrom (1958, 1976). 1) = now living within 50 miles; 2) = not living locally but elsewhere in Great Basin; 3) = not presently within the Great Basin; ? = age assignment in question.

	Present in Snake Range or nearby valley	Modern packrat midden	4000 to 6000 yr B.P.	11 000 to 12 000 yr B.P.	12 000 to 13 000 yr B.P.	13 000 to 14 000 yr B.P.	Smith Creek Cave: Reddish-brown Silt Zone ≥ 12 000–?≥ 28 000 yr B.P. (see text for discussion)	27 000 to 28 000 yr B.P.	Age unknown (Brattstrom 1976)
Fish									
Salmo clarki							X		
Gila atraria							X		
Amphibians									
Scaphiopus cf. *intermontanus*	X			X			X		
S. cf. *hammondi* (B)	3								X
Bufo boreas	2						X		
Bufo cf. *woodhousei*	1						X		
Bufo sp. (B)							X		
Rana sp.							X		
Reptiles									
Crotaphytus collaris	X						X		
Crotaphytus wislizeni	X						X		
Crotaphytus sp.							X		X
Sceloporus magister	2						X		
Sceloporus occidentalis or *undulatus*	X						X	X	
Sceloporus graciosus (B)	X						X		X
Sceloporus sp.							X		
Uta stansburiana (B)	X	X							X
Phrynosoma platyrhinos (B)	X						X		X
Phrynosoma douglassi	2					X	X	X	
Phrynosoma sp. (G)							X		
Cnemidophorus cf. *tigris*	X						X		
Coluber constrictor (G, B)	X						?		X
Masticophis flagellum (B)	2						?		X
Pituophis melanoleucus (G, B)	X						X		X
Lampropeltis getulus (G, B)	X						?		X
Lampropeltis pyromelana	X						X		
Lampropeltis triangulum	3						X		
Rhinocheilus lecontei	X	X					X		
Thamnophis sp. (G)							X		
Hypsiglena torquata (G, B)	X			X			X		X
Crotalus cf. *viridis* (G)	X						X		
Crotalus viridis (B)							X		X

Pine and Sheep Dung Zone (Bryan 1979*a*). Presumably this radiocarbon date provides a minimum age estimate for the Laminated Pink Silt and Rubble Zone and by correlation the Reddish-brown Silt unit.

The third depositional unit Bryan described from the rear of the cave is the Grey Silt, Rubble, and Dung Zone. Organic remains are very common within this unit. All bones incorporated in this uppermost unit are various shades of white without permineralization. Occasional mixing of the red-stained bones by bioturbation has occurred near the lower boundary of the unit. Although this unit has not been radiocarbon dated, it certainly is younger than 10 000 yr B.P. and the upper portion probably is less than 3000 years old (Bryan 1979*a*).

Results

Table 3 is a chronological check-list of late Pleistocene and Holocene age fish, amphibians, and reptiles from Smith Creek Canyon. Many of these taxa have not been reported previously from the late Pleistocene of the Great Basin. Table 4 is an updated check-list of fossil mammals known from Smith Creek Canyon. Although previous reports have described the mammals (Harrington 1934, Stock 1936, Goodrich 1965, Miller 1979), this table shows their stratigraphic provenience, not adequately given before.

Following is an annotated list of the fossil fish, amphibians, reptiles, and mammals that we recovered from packrat middens and from one sedimentary layer (Reddish-brown Silt) in Smith Creek Cave. Abbreviations for the fossil localities are listed in Table 2. The number in parentheses refers to the quantity of that element. We follow the nomenclature and ordering, unless otherwise stated, of Smith (1978) for the fish, of Stebbins (1966) for the amphibians and reptiles, and of Jones et al. (1979) for the mammals.

Class Osteichthyes
Family Salmonidae
Salmo clarki (Cut-throat Trout)

Material.—SCC Sed.: R angular, R dentary, vertebrae (25).

Remarks.—The right angular resembles that of a small individual of the Great Basin, not of the Colorado River. The right dentary is of a specimen of approximately 100 mm in length. All the vertebrae are of small individuals. The skeletal elements were identified as *Salmo* rather than *Salvelinus malma* (Dolly Varden, the other trout in the Great Basin) because (1) the angle between the coronoid and post-dorsal process of the angular is near 90°, and (2) the dentary lacks the deep groove under the tooth platform. The small size of the specimens suggest that they were from a creek (Smith Creek?), not a lake (Lake Bonneville) (Gerald R. Smith identifications and personal communication 1981).

Distribution.—*Salmo clarki*, which occurred in Lake Bonneville during the Pleistocene, is the widespread trout of the Great Basin and Intermountain Region (Smith et al. 1968, Smith 1978).

Family Cyprinidae
Gila atraria (Utah Chub)

Material.—SCC Sed.: Basioccipital and vertebrae (3).

Remarks.—The basioccipital with a pharyngeal process has the shape and angles of *Gila atraria*, not *Richardsonius belteatus* (Redside Shiner), which has a less ovoid haemal canal and a less obtuse angle between the cranial part of the bone and its pharnygeal process. The basioccipital belonged to a fish about 110 mm long (Gerald R. Smith identification and personal communication 1981).

Distribution.—*Gila atraria* is native to the Bonneville and upper Snake River drainages and occurred in Lake Bonneville during the Pleistocene (Smith et al. 1968, Smith 1978).

Class Amphibia
Order Salientia
Family Pelobatidae
Scaphiopus cf. *intermontanus* (Great Basin Spadefoot Toad)

Material.—SCC 1: tibiofibula; SCC Sed.: tibiofibulae (13), radio-ulnae (3).

Remarks.—No comparative material was available for *Scaphiopus intermontanus* although we have an excellent series of the closely related *S. hammondi*.

Distribution.—Only this species of spadefoot toad presently occurs within woodlands and sagebrush areas in the Great Basin (as well as in the Snake Range); however, *S.* cf. *hammondi* has been identified from an unprovenienced level in Smith Creek Cave (Brattstrom 1976).

Family Bufonidae
Bufo boreas (Western Toad)

Material.—SCC Sed.: sacral vertebra, R ilium.
Distribution.—*Bufo boreas* presently occurs throughout most of the Great Basin except the drier eastern part along the Nevada-Utah border; it has not been found in the Snake Range.

Bufo cf. *woodhousei* (Woodhouse's Toad)

Material.—SCC Sed.: tibiofibula.
Remarks.—Martin (1973) used the ratio of the tibiofibula, minimum width relative to length, to differentiate species of *Bufo* (*B. boreas*: 690–760; *B. cognatus*: 840–1050; *B. hemiophrys*: 950–1160; *B. microscaphus*: 670–850; and *B. woodhousei*: 770–950). The ratio of the Smith Creek Cave sediment fossil is 1013 (1.84/18.16 mm × 10 000), being relatively stout and thick in the middle. Although our fossil could be identified as *B. cognatus* based upon the tibiofibula ratio, we refer our specimen to *B. woodhousei* because of its present closer distribution; *B. cognatus* does not live in the Great Basin. Additional fossils of *Bufo* are needed to refine our identification.
Distribution.—*Bufo woodhousei* presently does not inhabit much of the Great Basin; the western edge of its range is just north and east of the Snake Range.

Bufo sp. (toad)

Material.—SCC Sed.: tibiofibulae (3), radio-ulna.
Remarks.—We were unable to identify the fragmented fossils to species.

Family Ranidae
Rana sp. (frog)

Material.—SCC Sed.: tibiofibulae (4), coracoid, atlas.
Remarks.—We were unable to assign the specimens to species.
Distribution.—Presently *R. pretiosa* and *R. pipiens* occur within the Great Basin (Stebbins 1966).

Class Reptilia
Order Squamata
Suborder Sauria
Family Iguanidae
Crotaphytus collaris (Collared Lizard)

Material.—SCC Sed.: L dentaries (3), R dentary.
Remarks.—*C. collaris* and *C. wislizeni* can be separated from most other iguanid lizards by their larger size and their dental characters. The individual teeth of *C. collaris* are relatively wide anteroposteriorly as compared to those of *C. wislizeni*, the posterior teeth strongly tricuspid, the anterior tending toward blunt spikes, some with a slight posterior curve. In *C. wislizeni* the anterior three-quarters of the teeth are sharp, recurved simple cusps with only a few posterior teeth tricusped.
Distribution.—The Collared Lizard occurs throughout the Great Basin in a variety of mountain and rocky habitats.

Crotaphytus wislizeni (Leopard Lizard)

Material.—SCC Sed.: L dentaries (2), L maxillae (3), R dentaries (3), R maxillae (4).

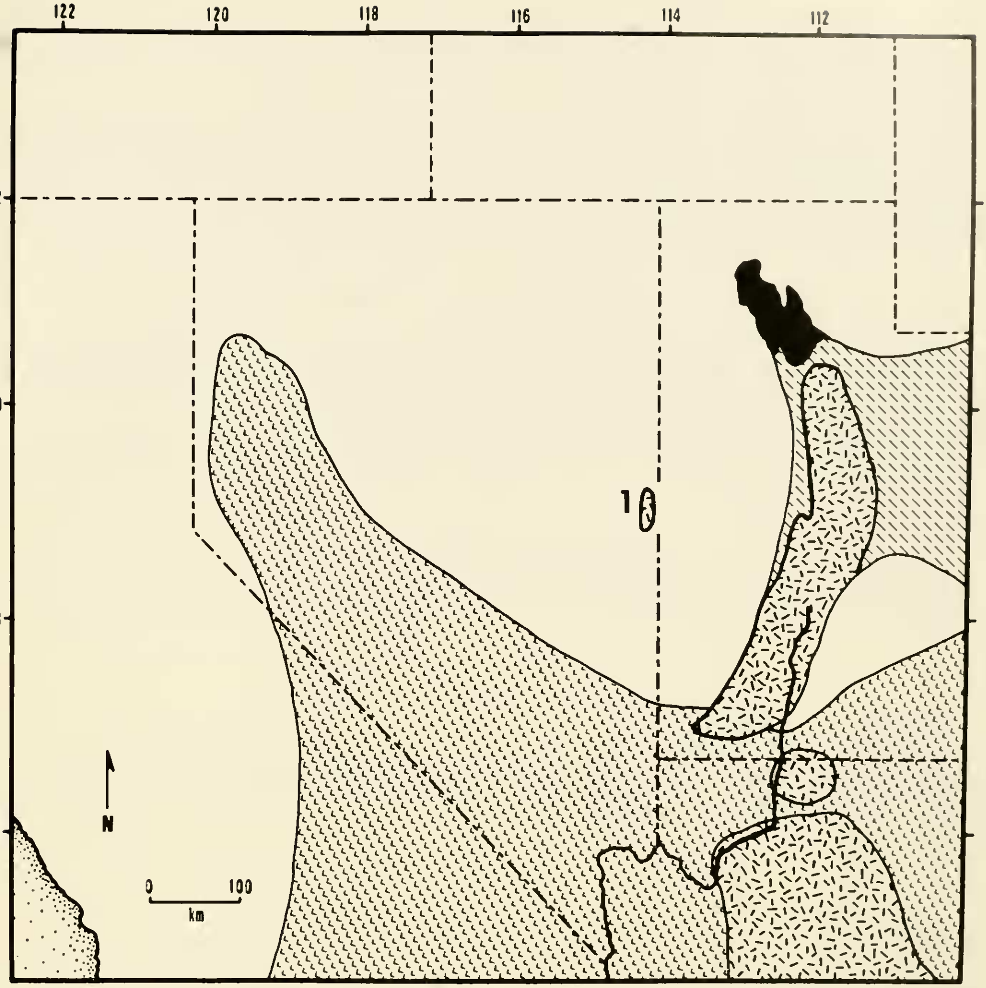

FIGURE 2. Present distributions of *Sceloporus magister* (L's), *Lampropeltis triangulum* (parallel lines), and *L. pyromelana* (mixed lines) (from Stebbins 1966). (1) Fossil localities and Snake Range. The distribution of *L. triangulum* overlaps the entire range of *L. pyromelana* only in Utah. The distribution of *S. magister* overlaps only the southern tip of both species of *Lampropeltis* in Utah and all of *L. pyromelana* in Arizona.

Remarks.—The distinguishing characters are listed under *C. collaris.*

Distribution.—Like the Collared Lizard, the Leopard Lizard occurs throughout the Great Basin, although usually in desertscrub communities on the finer alluvial habitats of the valleys.

Crotaphytus sp. (Collared or Leopard Lizard)

Material.—SCC Sed.: L dentaries (2), L maxillae (3), R dentaries (2), R maxilla.

Remarks.—We were unable to assign these elements to species.

Sceloporus magister (Desert Spiny Lizard)

Material.—SCC Sed.: L dentary.

Remarks.—The Desert Spiny Lizard can be differentiated from other sceloporine lizards of the Great Basin by its larger size.

Distribution.—The range of *S. magister* presently ends southwest of the Snake Range (Fig. 2). Although no other spiny lizards reach the size of *S. magister* in the Great Basin, other very similar sized species occur farther south in southern Arizona (*S. clarki* and *S. jarrovi*).

Sceloporus occidentalis or *undulatus* (Western or Eastern Fence Lizard)

Material.—LC 2a: epidermal scale; SCC Sed.: L dentaries (6), R dentaries (2), R maxillae (5), frontal.

Remarks.—There are no satisfactory dental criteria for separating the closely related *S. undulatus* and *S. occidentalis*; both species have larger races at their northern distribution. Since the latter species now lives within the Snake Range, we refer our fossils to it. The nearest population of *S. undulatus* is to the east in Utah. Both species possibly occurred within the mountain range in the late Pleistocene.

Sceloporus graciosus (Sagebrush Lizard)

Material.—SCC Sed.: R dentaries (2), frontal.

Remarks.—The skeletal elements of *S. graciosus* can be differentiated from those of other sceloporine lizards of the Great Basin by their distinctly smaller adult size and their slender pointed teeth with weakly developed secondary cusps.

Distribution.—*S. graciosus* now occurs throughout the Great Basin including the Snake Range.

Sceloporus sp. (spiny lizard)

Material.—SCC Sed.: L dentaries (2), L maxilla, R dentary, R maxillae (2).

Remarks.—We were unable to assign these elements to species.

Uta stansburiana (Sideblotched Lizard)

Material.—LC modern: L dentary.

Remarks.—The single element compared well with modern *Uta stansburiana*. The lizard presently lives in Smith Creek Canyon, and the only skeletal specimen recovered in our study came from a modern packrat midden.

Phrynosoma douglassi (Short-horned Lizard)

Material.—LC 2a: frontal; LC 3: L maxilla; SCC Sed.: L dentary, R maxillae (2), frontal.

Remarks.—The recovered dentary, maxillae, and frontals could not be distinguished from those of modern *P. douglassi*. In bone and dental characters of the frontal, dentary, and maxilla, *P. douglassi* are distinct from *P. platyrhinos* (Robinson and Van Devender 1973). *P. douglassii* has tall *Sceloporus*-like teeth with well-developed secondary cusps and a rounded bottom to the dentary. *P. platyrhinos* has short peg-like teeth with reduced secondary cusps.

Phrynosoma platyrhinos (Desert Horned Lizard)

Material.—SCC Sed.: L dentary.

Distribution.—Both *Phrynosoma platyrhinos* and *P. douglassi* live within the Great Basin today, the latter only at higher elevations on a few mountain ranges in northeastern Nevada (Stebbins 1966).

Family Teiidae

Cnemidophorus cf. *tigris* (Western Whiptail Lizard)

Material.—SCC Sed.: R dentaries (4).

Remarks.—We refer our specimens to *C.* cf. *tigris* because it is the only species of whiptail lizard now living within the interior Great Basin. Modern *C. tigris* and the fossils have very large dentaries. Other species of whiptail (e.g., *C. burti*) with dentaries of similar size now occur far south of the Great Basin.

Suborder Serpentes
Family Colubridae
Pituophis melanoleucus (Gopher Snake)

Material.—SCC Sed.: palatine, vertebrae (23).

Remarks.—The vertebrae of *Pituophis melanoleucus* are most similar to those of *Elaphe*. We used the criteria described by Auffenberg (1963) to differentiate the two species.

Distribution.—The Gopher Snake is very common throughout the Great Basin.

Lampropeltis pyromelana (Sonoran Mountain Kingsnake)

Material.—SCC Sed.: vertebrae (29).

Remarks.—The vertebrae of *Lampropeltis pyromelana* are typical of kingsnakes, with well-developed subcentral ridges. We differentiate *L. pyromelana* from *L. triangulum* by two criteria: (1) the cotyle and condyle are proportionally larger in *L. pyromelana* at all stages of growth, and (2) the accessory processes are fairly pointed on *L. pyromelana* whereas they are longer and globose (as viewed anteriorly) on *L. triangulum*. Both species have low neural spines unlike *L. getulus* or *Rhinocheilus lecontei*.

Distribution.—The Sonoran Mountain Kingsnake presently occurs only in a few relictual populations in the Great Basin including the Snake Range (Fig. 2). It commonly occurs in the central and southern Wasatch Mountains and the mountainous region farther south and west.

Lampropeltis triangulum (Milksnake)

Material.—SCC Sed.: vertebra.

Remarks.—The distinguishing criteria were discussed under *L. pyromelana*.

Distribution.—The Milksnake occurs on the eastern periphery of the Great Basin in the Wasatch Mountains and farther south in Utah but not as far west as the Snake Range (Fig. 2).

Rhinocheilus lecontei (Long-nosed Snake)

Material.—LC modern: vertebra; SCC Sed.: vertebrae (13)

Remarks.—The vertebrae of *Rhinocheilus* are quite characteristic and can readily be identified (Hill 1971, Van Devender and Mead 1978).

Distribution.—The Long-nosed Snake lives throughout the Great Basin except for the northwesternmost region.

Thamnophis sp. (garter snake)

Material.—SCC Sed.: vertebrae (3).

Remarks.—We were unable to assign the specimens to species.

Distribution.—Presently *T. elegans* (Wandering Garter Snake) lives within the Great Basin, including the Snake Range, and *T. sirtalis* (Common Garter Snake) borders parts of the basin (Stebbins 1966).

Hypsiglena torquata (Night Snake)

Material.—CHC 1b: vertebra; SCC Sed.: L dentary, vertebrae (36).

Remarks.—*H. torquata* has small generalized colubrid vertebrae, which are very similar to those of other small snakes such as *Sonora semiannulata*. Identification criteria used here were those used by Van Devender and Mead (1978).

Distribution.—The Night Snake occurs over most of the Great Basin.

TABLE 4. Wisconsinan and Holocene mammals from Smith Creek Canyon, Nevada. The stratigraphic units discussed under Smith Creek Cave follow the nomenclature described by Bryan (1979*a*); their age assignments are discussed in this text. (*) = extinct taxa. (!) = this report represents the first reporting of this taxon from Smith Creek Canyon. (?) = We and/or others question the identification or age assignment. Systematic arrangement follows Jones et al. (1979).

		Smith Creek Canyon packrat middens. Age in yr B.P.									Smith Creek Cave sediments						Council Hall Cave	Amys Shelter	Ka-china Cave
													Stratigraphic unit					
	Presently in Snake Range or immediate valley	4000–6000	6000–8000	8000–10 000	10 000–11 000	11 000–12 000	12 000–13 000	13 000–14 000	17 000–18 000	27 000–28 000	Goodrich 1965	Miller 1979	This report	Generalized—all levels	Reddish-brown Silt ≥12 000 yr B.P. (see text)	Grey Silt, Rubble and Dung ≤10 000 yr B.P. and other Holocene units	?≥23 000 yr B.P. Age not given (Miller 1979, Bryan 1979b)	Approximate (?) 1500–5000 yr B.P. (Miller 1979, Gruhn 1979)	Approximate (?) 600–2100 yr B.P. (Miller 1979, Tuohy 1979)
Soricidae	X											X			X			X	
Chiroptera	X											X	X	X	X		X		
Antrozous cf. *pallidus*	X										X			?	?	?			
Ochotona cf. *princeps*			X	X	X		X		X				X		X				
Ochotona princeps											X	X		X	X	X	X		
Sylvilagus idahoensis (!)	X						X												
Sylvilagus sp.	X											X	X	X	X	X	X	X	X
Lepus cf. *californicus*	X										X			?	?				
Lepus sp.	X										X	X	X	X	X	X	X	X	X
Eutamias minimus (!)	X												X		X				
E. cf. *umbrinus* (!)	X												X		X				
Eutamias sp.	X											X	X	X	X	X	X		X
Marmota flaviventris	X										X	X	X	X	X		X	X	
Ammospermophilus leucurus (!)	X									X			X		X				
Spermophilus cf. *townsendii*	X										?	X		X				X	
S. cf. *richardsonii* (!)						X	X						X						
S. cf. *beldingi* (!)	X								X				X						

TABLE 4. Continued.

		Smith Creek Canyon packrat middens. Age in yr B.P.									Smith Creek Cave sediments						Council Hall Cave	Amys Shelter	Kachina Cave
														Stratigraphic unit					
	Presently in Snake Range or immediate valley	4000–6000	6000–8000	8000–10 000	10 000–11 000	11 000–12 000	12 000–13 000	13 000–14 000	17 000–18 000	27 000–28 000	Goodrich 1965	Miller 1979	This report	Generalized—all levels	Reddish-brown Silt ≥12 000 yr B.P. (see text)	Grey Silt, Rubble and Dung ≤10 000 yr B.P. and other Holocene units	?≥23 000 yr B.P. Age not given (Miller 1979, Bryan 1979b)	Approximate (?) 1500–5000 yr B.P. (Miller 1979, Gruhn 1979)	Approximate (?) 600–2100 yr B.P. (Miller 1979, Tuohy 1979)
S. variegatus	X																X		
S. cf. *lateralis* (!)	X					X				X			X		X				
Spermophilus sp.	X									X	X		X	X	X		X		X
Thomomys cf. *talpoides*	?										X	X		X	X	X			
Thomomys sp.	X											X	X	X	X		X		X
Perognathus cf. *parvus*	X											X			X				
Perognathus sp.	X					X			X				X		X		X		X
Microdipodops cf. *megacephalus*												X			X				
Dipodomys cf. *ordii*	X											X			X				
Dipodomys sp.	X												X		X				X
Peromyscus sp.	X										X	X	X	X	X	X	X		X
Neotoma lepida	X	X	X						X		X	X	X	X	X		X	X	X
N. cinerea	X	X	X			X						X	X		X		X	X	X
Neotoma sp.	X	X	X	X	X	X	X	X	X	X			X		X				
N. lepida or *cinerea*	X	X	X										X		X				
Phenacomys cf. *intermedius* (!)													X		X				
Microtus cf. *montanus*	X										X			X	X	X			
M. cf. *longicaudus* (!)	X								X				X		X				
Microtus sp.	X						X		X			X	X	X	X		X	X	X
Erethizon dorsatum	X											X			X			X	

TABLE 4. Continued.

		Smith Creek Canyon packrat middens. Age in yr B.P.									Smith Creek Cave sediments						Council Hall Cave	Amys Shelter	Ka-china Cave
														Stratigraphic unit					
	Presently in Snake Range or immediate valley	4000–6000	6000–8000	8000–10 000	10 000–11 000	11 000–12 000	12 000–13 000	13 000–14 000	17 000–18 000	27 000–28 000	Goodrich 1965	Miller 1979	This report	Generalized—all levels	Reddish-brown Silt ≥12 000 yr B.P. (see text)	Grey Silt, Rubble and Dung ≤10 000 yr B.P. and other Holocene units	?≥23 000 yr B.P. Age not given (Miller 1979, Bryan 1979b)	Approximate (?) 1500–5000 yr B.P. (Miller 1979, Gruhn 1979)	Approximate (?) 600–2100 yr B.P. (Miller 1979, Tuohy 1979)
Canis cf. *latrans*	X											X			X		X	X	X
C. cf. *lupus*	?										X				?				
Vulpes vulpes	X											X			X				
V. velox												X			X				
Ursus sp.											X			?	?				
Bassariscus astutus	X										X			X	X				
Martes nobilis (*)												X			X				
Martes sp.											X				X				
Mustela erminea	X											X			X				
M. frenata	X											X				X			
M. vison												X			X				
Mustela sp.	X										X				X				
Taxidea taxus	X										X	X			X			X	X
Spilogale putorius	X												X		X				
Spilogale sp.	X										X	X			X	X			
Felis rufus	X										X	?		X	X			X	X
F. cf. *onca*											X				X				
F. onca												X			X				
F. concolor	X										X	?		X	X				X
?*F. atrox* (*)												X			?				
Equus sp. (Large) (*)											X	X			X				

TABLE 4. Continued.

		Smith Creek Canyon packrat middens. Age in yr B.P.									Smith Creek Cave sediments						Council Hall Cave	Amys Shelter	Ka-china Cave
														Stratigraphic unit					
	Presently in Snake Range or immediate valley	4000–6000	6000–8000	8000–10 000	10 000–11 000	11 000–12 000	12 000–13 000	13 000–14 000	17 000–18 000	27 000–28 000	Goodrich 1965	Miller 1979	This report	Generalized—all levels	Reddish-brown Silt ≥12 000 yr B.P. (see text)	Grey Silt, Rubble and Dung ≤10 000 yr B.P. and other Holocene units	?≥23 000 yr B.P. Age not given (Miller 1979, Bryan 1979b)	Approximate (?) 1500–5000 yr B.P. (Miller 1979, Gruhn 1979)	Approximate (?) 600–2100 yr B.P. (Miller 1979, Tuohy 1979)
Equus sp. (Small) (*)											X	X			X				
Camelops sp. (*)											X	X			X				
?*Hemiauchenia* sp. (*)												X			X				
Cervus elaphus												X			X	?			
Odocoileus sp.	X										X			?	?		?	X	
Antilocapra americana	X											X		X	X	X	?		X
cf. *Antilocapra*	X																	X	
Antilocapridae	X										X				?				
?*Breameryx* sp. (*)												X			X				
?*Bison* sp.												X			X				X
Oreamnos harringtoni (*)											X	X			X				
Oreamnos americanus																	?		
cf. *Oreamnos*												X						X	
Ovis canadensis	X											X		X	X	X	X	X	X
?*Ovis aries*	?																?		
Ovis sp.	X										X			X	X	X			

Family Viperidae

Crotalus cf. *viridis* (Western Rattlesnake)

Material.—SCC Sed.: vertebrae (5)

Distribution.—We refer our specimens to *C. viridis* because they are from a medium-sized rattlesnake and this species presently inhabits the Great Basin. *C. mitchelli* is very similar but occurs no farther north than the Mohave Desert.

Class Mammalia

Order Chiroptera

Genus and species indeterminate

Material.—SCC Sed.: isolated teeth, mandible.

Remarks.—The isolated teeth and the fragment of a mandible did not allow generic identification.

Distribution.—Many species of bats occur in the Great Basin (Barbour and Davis 1969).

Order Lagomorpha

Family Ochotonidae

Ochotona cf. *princeps* (pika)

Material.—SCC 4: dung pellets (17), RM^1; SCC 5: dung pellets (2), RP^3; SCC Sed.: LP_3; STV 1: dung pellet; STV 2: dung pellets (>50); STV 3: dung pellets (3).

Remarks.—The RP^3 from SCC 5 is referred to *Ochotona*, but in view of its worn state, it could possibly be a *Sylvilagus idahoensis*. Miller (1979) reported that pika remains were recovered in all stratigraphic units in Smith Creek Cave; the youngest occurrence, however, cannot be determined. Pika also was recovered from Council Hall Cave; unfortunately, the remains (not described) were not reported in relation to the testpits, stratigraphy, or associated radiocarbon age (Miller 1979, Bryan 1979*b*). Small mammal bones (*Ochotona*?) occurred throughout the upper two meters (above a 23 900 ± 970 yr B.P. radiocarbon date, GaK-5100) of organic layers in Test Pit 2 (Bryan 1979*b*).

Two packrat middens in Smith Creek Cave and three middens in Streamview Shelter contained lagomorph dung pellets referable to *Ochotona* cf. *princeps* (Fig. 3). Dung pellets from each packrat midden were measured (length and width) and the measurements compared with those from samples from modern *Ochotona princeps*, *Sylvilagus idahoensis*, and *S. nuttallii*. The advantage of the preserved dung pellets from the packrat middens over the skeletal fragments from the cave sediments is that presumably *Ochotona* lived at the fossil site and was not brought there via a raptor stomach. Pika (skeletal remains) has been identified previously from mountain ranges outside its present distribution and from elevations below its current lower limit in ranges it now inhabits (Fig. 4; Grayson 1977, 1981, *in press a, b*, Miller 1979). To our knowledge, this is the first record of late Pleistocene age dung of *Ochotona* south of the permafrost in North America (Guthrie 1973). A more detailed account of the fossil *Ochotona* in the Great Basin is in progress.

Distribution.—Pika does not now live in the Snake Range or in any nearby mountains (Hall 1946, Hall and Kelson 1959), although it does inhabit the mountainous regions on the west, north, and east sides of the Great Basin (Fig. 4). Only *O. p. nevadensis* (Ruby Mountains region) and *O. p. tutelata* (Toquima Range and Desatoya Mountains) live in restricted relictual localities within the interior Great Basin.

Family Leporidae

Sylvilagus (=*Brachylagus*) *idahoensis* (Pygmy Rabbit)

Material.—SCC Sed.: M_3.

Remarks.—*S. idahoensis* has not been previously recorded from Smith Creek Canyon (Miller 1979). In the central Great Basin at Gatecliff Shelter, the Pygmy Rabbit

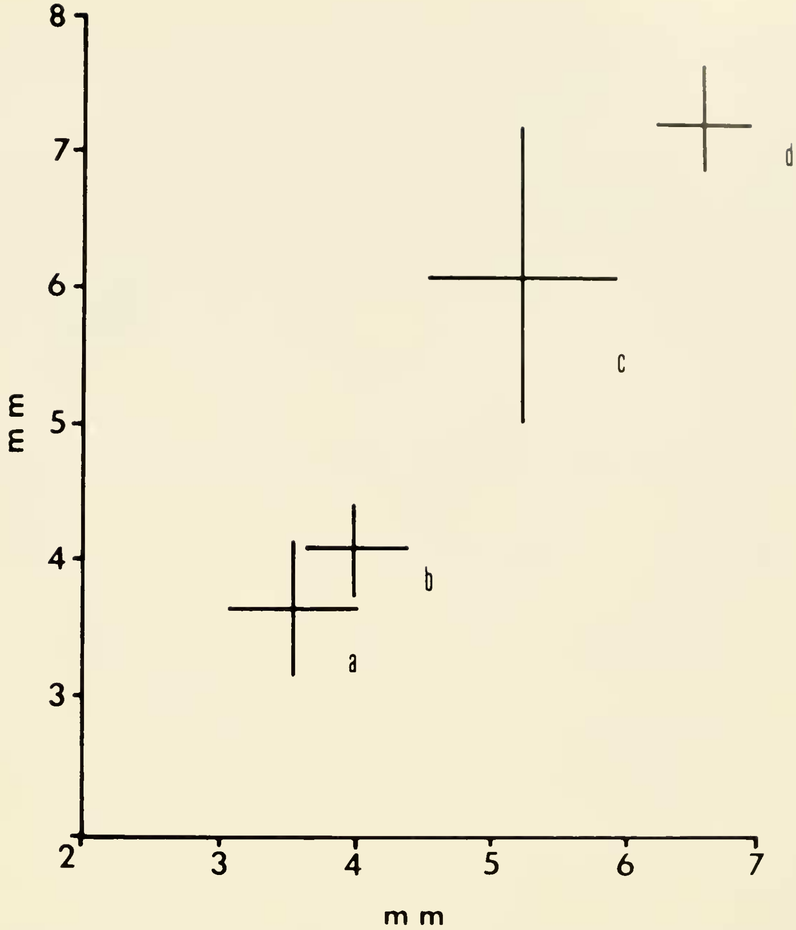

FIGURE 3. Measurements (width and length) of lagomorph dung pellets. (a) *Ochotona* cf. *princeps*, fossil, this report; (b) *O. princeps*, modern, California; (c) *Sylvilagus idahoensis*, modern, Nevada; (d) *S. nuttallii*, modern, Nevada.

was recovered throughout the deposit (Grayson *in press b*). North of the Great Basin, *S. idahoensis* is recorded in late Pleistocene context at Jaguar Cave (Guilday and Adams 1967), Wasden site (Owl Cave, Guilday 1969), and Moonshiner Cave (Anderson 1974). South of the Great Basin it is reported from Tule Springs, Nevada (Mawby 1967) and Isleta Cave, New Mexico (Harris 1977).

Distribution.—The Pygmy Rabbit presently occurs across the northern and east-central Great Basin (Hall 1946).

Sylvilagus sp. (rabbit)

Material.—SCC Sed.: RP^3.
Remarks.—The specimen could not be identified to species.

Lepus sp. (hare)

Material.—SCC Sed.: RM_3.
Remarks.—The specimen could not be identified to species.

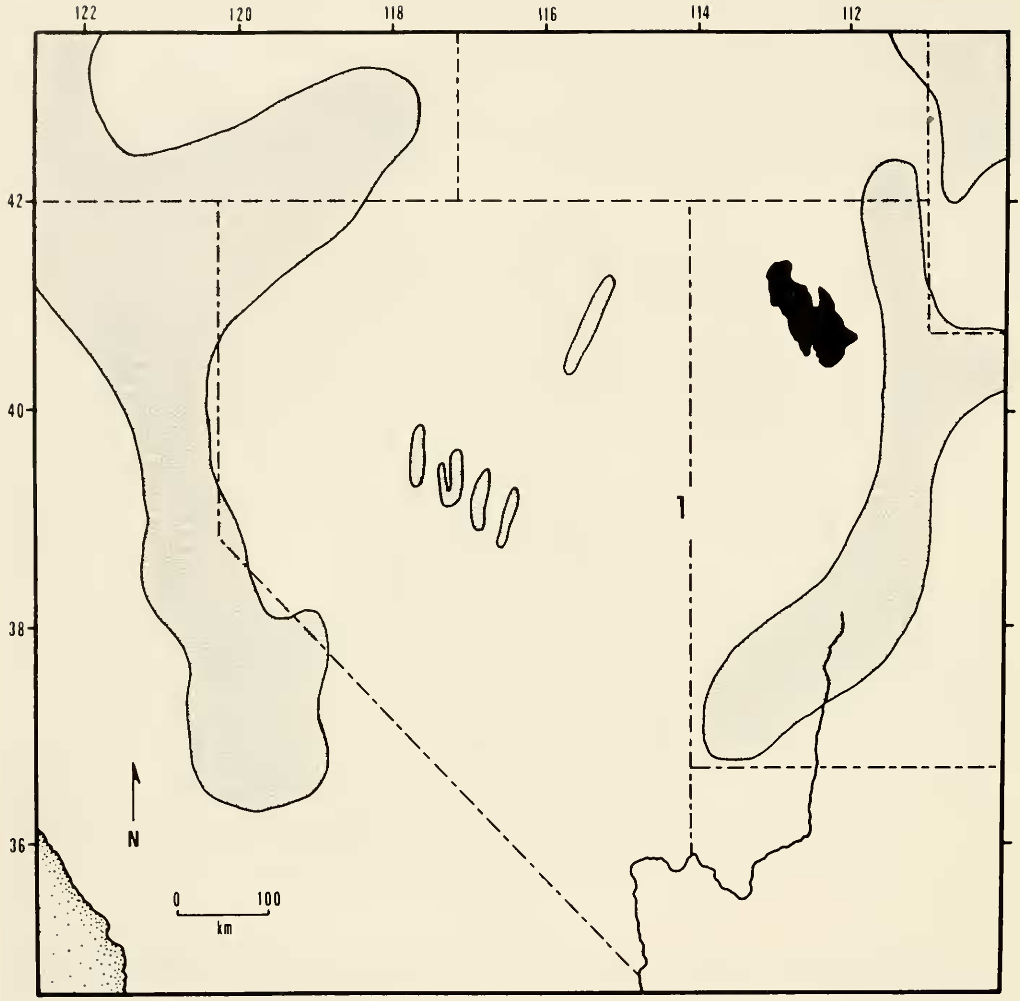

FIGURE 4. Distribution of *Ochotona princeps* on isolated mountains within and bordering the Great Basin (from Hall 1946, Hall and Kelson 1959). (1) Fossil localities of Smith Creek Canyon and Garrison.

Order Rodentia
Family Sciuridae
Eutamias minimus (Least Chipmunk)

Material.—SCC Sed.: R mandible P_4M_{1-3}.

Remarks.—This is the smallest chipmunk in Nevada. Assignment of our specimens to this species was on the basis of size. Although the other species of *Eutamias* of the Great Basin are restricted to the vicinity of coniferous trees, *E. minimus* may live in sagebrush (*Artemisia tridentata*) at both high and low elevations (Hall 1946).

Eutamias cf. *umbrinus* (Uinta Chipmunk)

Material.—SCC Sed.: frontal.

Remarks.—Neither of the two species of *Eutamias* have been reported from Smith Creek Canyon (Miller 1979). Our specimen compared most favorably with modern *E. umbrinus*.

Distribution.—The Uinta Chipmunk is a medium-sized chipmunk that presently occurs in the Snake Range (Hall 1946).

Eutamias sp. (chipmunk)

Material.—SCC Sed.: LM_1 (2), RM_1, RM^1 (3), LM^3, RM^3.

Marmota flaviventris (Yellow-bellied Marmot)

Material.—SCC Sed.: LI.
Remarks.—Although we are assuming our specimen is *M. flaviventris*, the isolated incisor does not allow for specific identification. The Hoary Marmot, *Marmota caligata*, cannot be ruled out definitively based upon our specimen, though its occurrence in the Great Basin in the late Pleistocene seems unlikely.
Distribution.—*Marmota flaviventris* presently occurs in the Snake Range at elevations higher than Smith Creek Cave.

Ammospermophilus leucurus (White-tailed Antelope Squirrel)

Material.—LC 2a: frontal; SCC Sed.: L mandible M_{1-2}.
Remarks.—The White-tailed Antelope Squirrel has not previously been reported from Smith Creek Canyon (Miller 1979). Our specimens compare with modern representatives of *A. leucurus*.
Distribution.—*Ammospermophilus leucurus* presently lives in most of the Great Basin, including the area of the Snake Range (Hall 1946).

Spermophilus cf. *richardsonii* (Richardson's Ground Squirrel)

Material.—LC 1: RM^3; LC 4: LM_3.
Remarks.—*Spermophilus richardsonii* has not been recovered previously from Smith Creek Canyon, though it has been recorded from the more northern localities of Jaguar Cave (Guilday and Adams 1967) and Moonshiner Cave (Anderson 1974), Idaho. Both Davis (1939) and Hall (1946) have expressed the belief that *S. richardsonii* must have occupied a much wider range over an ecological area now filled by *S. beldingi* and *S. armatus*. On the basis of the Smith Creek Canyon fossils of *S.* cf. *richardsonii*, we concur with them. Our two specimens compared most favorably with modern *S. richardsonii*.
Distribution.—Richardson's Ground Squirrel does not occur presently in the Snake Range. The present distribution of *S. r. nevadensis* in the Great Basin is centered in the Independence Mountains of northern Nevada, and it occurs no farther south than the Roberts Mountains (Hall 1946).

Spermophilus cf. *beldingi* (Belding's Ground Squirrel)

Material.—LC 2b: L maxilla M^1.
Remarks.—*Spermophilus beldingi* has not been reported previously from Smith Creek Canyon, and the only other published fossil or subfossil record for Belding's Ground Squirrel in the Great Basin is from Stratum 3 at Gatecliff Shelter (Grayson *in press b*). Our single specimen compared most favorably with modern *S. beldingi*.
Distribution.—*Spermophilus beldingi* is ecologically and physically very similar to *S. richardsonii*. Belding's Ground Squirrel presently does not occur in the Snake Range or in any immediate mountain range. Its present distribution centers in the northern Sierra Nevada and in the higher mountains of north central and northern Great Basin, though it occurs farther south than *S. richardsonii*, down to the Toquima Range (Hall 1946).

Spermophilus cf. *lateralis* (Golden-mantled Ground Squirrel)

Material.—LC modern: RM_1; LC 2a: L maxilla M^{1-3}, L mandible M_{1-3}; SCC 1: R mandible P_4M_1; SCC Sed.: R mandible M_{1-2}, RM_3, LM^1, RM_{1-2}.
Remarks.—Although *S. lateralis* was not previously reported from Smith Creek Canyon (Miller 1979), it is fairly widespread in the Smith Creek Canyon fossil localities

and apparently was common in the canyon throughout most of the late Pleistocene. Although we have found this to be the most common species of *Spermophilus*, Miller (1979) considered that *S.* cf. *townsendii* was the most prevalent in the Smith Creek Cave record. Miller (1979) stated that Goodrich (1965) referred his specimens from Smith Creek Cave to *S.* cf. *townsendii*; although he considered that species, he did not definitely refer his specimens there. However, the presence of Townsend's Ground Squirrel in Smith Creek Canyon in the late Pleistocene seems plausible.

Spermophilus sp. (ground squirrel)

Material.—LC 2b: RM_1; SCC Sed.: P^4 (3), RM_3, RM^3.

Family Geomyidae
Thomomys sp. (pocket gopher)

Material.—SCC Sed.: LM^1.
Remarks.—We were unable to assign our single specimen to a species.

Family Heteromyidae
Perognathus sp. (pocket mouse)

Material.—SCC 1: L mandible P_4 (3), R mandible, R maxilla M^1; SCC Sed.: L mandible, R maxilla M^1 (2); STV 2: L maxilla (2), R maxilla.
Remarks.—We were unable to assign these specimens to species.

Dipodomys sp. (kangaroo rat)

Material.—SCC Sed.: LP^4.
Remarks.—We were unable to assign this specimen to species.

Family Cricetidae
cf. *Peromyscus* (white-footed mouse)

Material.—CHC 1b: RM^{1-2}; SCC 1: LM^1; SCC Sed.: LM^1, $RM^{1,3}$; STV 2: LM_1, RM^{1-2}; STV 3: LM_{1-2}.
Remarks.—We have not identified these specimens to species because we do not have available a sufficient comparative collection of *Reithrodontomys* and *Peromyscus* from Nevada. Presently *Reithrodontomys megalotis, Peromyscus eremicus, P. crinitus, P. maniculatus, P. boylii,* and *P. truei* live in or near the Great Basin. Previous work at Smith Creek Cave has produced specimens assigned to *Peromyscus* sp., but *Reithrodontomys* and *Onychomys* have not been identified from the fossil localities in Smith Creek Canyon, though they very well may be included.

Neotoma lepida (Desert Packrat)

Material.—CHC 1a: LM^{1-2}; CHC 1b: LM_1 (2); SCC Sed.: LM_1 (2), RM_1 (2), RM^1 (3), LM^1 (8); STV 2: RM^2.

Neotoma cinerea (Bushy-tailed Packrat)

Material.—CHC 1a: LM^1, RM^1 (2); CHC 1b: LM_1, LM^1; SCC 1: lower leg assemblage with hide; SCC Sed.: RM_1, RM^1 (7).
Remarks.—*Neotoma lepida* and *N. cinerea* are found living in Smith Creek Canyon. Their middens, both modern and fossil, can be found throughout the Great Basin. The excellent preservation and the advantages of having a packrat midden are illustrated by the partial mummy of the hind quarters of the Bushy-tailed Packrat (ca. 11 600 yr B.P.). Molars of *N. cinerea* are generally larger than those of *N. lepida*.

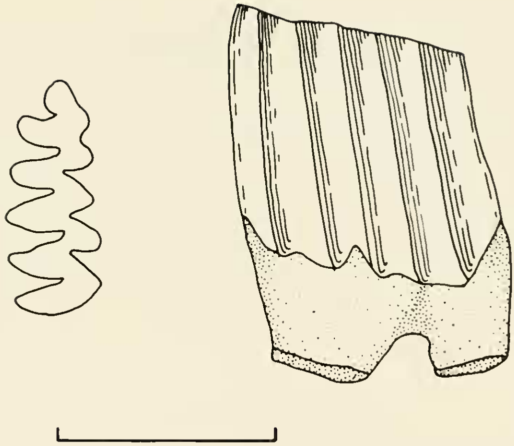

FIGURE 5. Occlusial (left) and lingual (right) views of the *Phenacomys* cf. *intermedius* RM_1 from Smith Creek Cave. Bar = 2 mm.

Neotoma lepida or *cinerea* (Desert or Bushy-tailed Packrat)

Material.—CHC 1a: RM^2; CHC 1b: L&RM^2 (5), LM_2 (2), M^3 (2), M_3 (2); SCC Sed.: LM_1 (2), RM_1 (2), L&RM_2 (17), L&RM^2 (8), M^3 (8), M_3 (8).

Neotoma sp. (packrat)

Material.—SCC Sed.: M_3; STV 2: M fragment.

Phenacomys cf. *intermedius* (Heather Vole)

Material.—SCC Sed.: RM_1.

Remarks.—Only one specimen was identifiable as *Phenacomys* cf. *intermedius*. Criteria for identification were the presence of tooth roots, lack of cementum, and distinctive occlusal pattern (Fig. 5; Guilday and Parmalee 1972). The isolated molar does not allow for specific identification.

Distribution.—The Heather Vole presently does not live in the Great Basin (Hall 1946). Our specimen from Smith Creek Cave is the first reported late Pleistocene *Phenacomys* from the Great Basin. Grayson (1981) has recovered a specimen from Gatecliff Shelter dating approximately 5300 yr B.P., which illustrates the middle Holocene survival of this presently extirpated mammal.

Microtus cf. *longicaudus* (Long-tailed Vole)

Material.—SCC Sed.: RM_1 (7), LM_1 (8), R mandible: STV 2: LM_3.

Remarks.—Our fossil specimens appear most similar to the Long-tailed Vole, although we find it difficult to differentiate *M. longicaudus* from *M. montanus*. Of the 15 fossil M_1's examined, 14 had five closed alternating triangles, 1 had six triangles. Only *M. montanus* has been reported from Smith Creek Cave (Goodrich 1965, Miller 1979). Goodrich compared his fossils with *M. californicus*, *M. montanus*, *M. townsendii*, *M. oregoni*, and *M. pennsylvanicus*; *M. longicaudus* was not compared.

Distribution.—*Microtus montanus* and *M. longicaudus* are the only species of meadow vole in Nevada (Hall 1946). Normally, *M. montanus* is found in the valleys and *M. longicaudus* in the mountains.

Microtus sp. (meadow vole)

Material.—LC 2b: RM_{1-2}; SCC 4: RM_1; SCC Sed.: LM^1 (3), RM^1 (3), LM^2 (4), LM_2 (4), RM_3 (2), LM_3 (2), RM^3.

Order Carnivora
Family Mustelidae
Spilogale putorius (Spotted Skunk)

Material.—SCC Sed.: L mandible $C_1P_{3-4}M_{1-2}$.

Remarks.—This is the only place where we disagree with the classification of Jones et al. (1979). We follow Kurten and Anderson (1980) and group the Western Spotted Skunk (*Spilogale gracilis*) with the Eastern Spotted Skunk (*S. putorius*). Our specimen from Smith Creek Cave has an alveolar length (anterior edge of C_1 to posterior edge of M_2) of 19.0 mm and an occlusial length of the M_2 of 2.1 mm. These measurements compare well with two modern specimens of *S. putorius* from the Ruby Mountains, Elko and White Pine Counties, Nevada.

Distribution.—The Spotted Skunk is common throughout the Great Basin.

Order Artiodactyla
Genus and species indeterminate

Material.—CHC 1a: dung pellets (15); SCC 1: keratinous hoof fragment; SCC Sed.: 1 fragment.

Remarks.—Because of fragmented state of preservation, we were unable to identify further these specimens.

Discussion and Summary

We report here the occurrence of 2 fish, 4 anurans, 9 lizards, 8 snakes, and 17 small mammals. This assemblage adds 15 amphibians and reptiles and 7 mammals to the approximately 46 animals previously known from the late Pleistocene and early Holocene of Smith Creek Canyon (Goodrich 1965, Miller 1979). Over half of the large herbivores (*Equus* spp., *Camelops* sp., ?*Hemiauchenia* sp., *Oreamnos harringtoni*, and ?*Breameryx* sp.) and the two carnivores (*Martes nobilis* and ?*Felis atrox*) reported from Smith Creek Canyon are extinct (Miller 1979). Our data add no large herbivore or carnivore species to the local fauna. Of the extant species from the fossil sites, 16 are not recorded from the Snake Range or in the immediate valleys (*Bufo boreas*, *Sceloporus magister*, *Phrynosoma douglassi*, *Lampropeltis triangulum*, *Masticophis flagellum*, *Ochotona princeps*, *Spermophilus* cf. *richardsonii*, *S.* cf. *beldingi*, *Phenacomys* cf. *intermedius*, *Vulpes velox*, *Ursus* sp., *Mustela vison*, *Martes* sp., *Felis onca*, *Cervus elaphus*, and ?*Bison* sp.).

Few large herbivores presently occur in the Snake Range. *Ovis canadensis* was reintroduced in the middle 1900s. The historic distributions of *Cervus elaphus* and *Bison bison* in the eastern Great Basin are not well known, though *Cervus* has been sighted in White Pine County (Hall 1946). The late Pleistocene occurrences of *Camelops* sp., ?*Hemiauchenia* sp., *Cervus elaphus*, *Odocoileus* sp., *Equus* (both large and small species), ?*Breameryx* sp., *Antilocapra americana*, *Oreamnos harringtoni*, *Ovis canadensis*, and ?*Bison* in Smith Creek Canyon are fairly well documented, although the exact timing (late or middle Wisconsinan) of these occurrences is not understood and is discussed below. We question the tentative identification of *Oreamnos americanus* reported from Council Hall Cave (Miller 1979). Although the estimated age is not reported for the modern mountain goat specimen (it is not known historically from the Great Basin), we speculate that the record, if *Oreamnos*, is of the extinct *Oreamnos harringtoni*.

If our reconstruction of the Smith Creek Canyon fauna-flora assemblage is correct, during the late Pleistocene, montane glaciers on Mount Moriah (3673 m elevation) moved down into the upper reaches of Smith Creek Canyon to an estimated elevation of 2900 m (Drews 1958). This was also a time when an open forest with *Pinus longaeva*, *P. flexilis*, and *Picea engelmannii* was present on the coarse talus and rock outcrops of the limestone entrance region of the canyon. Alluvial substrates in the canyon bottom probably supported a mosaic of *Artemisia* spp., shrubs, meadows, and riparian

Table 5. Fauna from two packrat middens on a rock outcrop in the middle of Snake Valley (1640 m elevation), near Garrison, Utah. (D) = dung. (B) = bone or tooth.

	Garrison No. 1 12 230 ± 180 yr B.P.	Garrison No. 2 13 480 ± 250 yr B.P.
Gastropoda		shell
Osteichthyes		B
Aves		B
Sorex sp.		B
Ochotona cf. *princeps*	D	B, D
Sylvilagus idahoensis	B	B
Thomomys sp.		B
Spermophilus sp.		B
cf. *Peromyscus*		B
Neotoma sp.	D	B, D
Microtus sp.	B	B
Camelops cf. *hesternus*		B
Ovis or *Odocoileus*		D

elements. This canyon bottom habitat and possibly the canyon slopes could have supported much of the fauna (e.g., *Phenacomys* and *Microtus*) recovered from the three caves and the rockshelters. *Ochotona* cf. *princeps* probably occurred on all suitable talus slopes throughout the unglaciated portions of the canyon from the creek level at Streamview to Smith Creek Cave.

Smith Creek Canyon empties into the broad Snake Valley to the east. During part of the late Wisconsinan a western arm of Lake Bonneville filled this valley to an elevation of 1580 m (Mifflin and Wheat 1979). This high lake stand was only 4 km from the entrance of Smith Creek Canyon. The late Pleistocene vegetation of the Snake Valley in the area above the lake level is poorly known.

Thirty km south of Smith Creek Canyon but still within Snake Valley, we recovered packrat middens from a rocky outcrop in the center of the valley (near the town of Garrison, Utah, 10 km east of the Snake Range, the closest mountain mass). The late Pleistocene age fauna-flora assemblage from the packrat middens is presumably an indication of the type of habitat above the pluvial lake level but below the mountain masses. The isolated rock outcrop provided a suitable habitat for limber pine and pika (Table 5; Thompson and Mead 1982). Adjacent areas appear to have been a shrub community, with some nearby areas of meadow. Megafauna of the valley consisted of at least *Camelops* cf. *hesternus* and *Ovis* or *Odocoileus* (Table 5). The Rancholabrean age fauna of Snake Valley is not well known. A cave acting as a natural trap has produced the skull of a wolverine (*Gulo gulo*), though unfortunately the age of the animal is not known (Barker 1976).

The density of the shrub communities below the mountain mass but above the lake level cannot be determined with certainty. The recovery of *Sylvilagus idahoensis* implies that at least some areas were fairly dense with tall stands of *Artemisia* spp. (Hall 1946). Conversely, the recovery of *Crotaphytus wislizeni* and *Phrynosoma platyrhinos* imply areas of relatively open to sparse habitat, possibly exposed playa adjacent to the lake.

Most of the fauna reported here (Tables 3 and 4) come from the inadequately dated Reddish-brown Silt Zone in Smith Creek Cave. We have already mentioned that the accuracy of the single radiocarbon date on bone fragments from the unit (ca. 28 000 yr B.P.) is suspect. The minimum age this unit could be is approximately 12 000 yr B.P., assuming the stratigraphic associations described by Bryan (1979*a*) are correct. Equally plausible is that the unit may date from the late Wisconsinan full glacial (ca. 18 000 to 22 000 yr B.P.) or even middle Wisconsinan (≥30 000 yr B.P.). The temporal depth of this unit also is not known. Because of these drawbacks we cannot definitely state when or what the faunal associations were in the late Pleistocene of Smith Creek

Canyon. We can state, however, that at least these taxa were in the canyon during the late Wisconsinan. This becomes important when considering the species such as *Ochotona*, *Phenacomys*, and other locally extirpated animals.

Tanner (1978) has stated that most of the present Great Basin Desert reptiles have extended their ranges into the Great Basin as post-Pleistocene introductions from a Pleistocene refugium of the southern deserts (Chihuahua, Coahuila, Sonora; Ballinger and Tinkle 1972). The late Wisconsinan records of *Crotaphytus wislizeni*, *Phrynosoma platyrhinos*, *Sceloporus magister*, *Hypsiglena torquata* and *Rhinocheilus lecontei* in the Smith Creek Canyon fauna presented here does not support Tanner's hypothesis. If the fauna from the Reddish-brown Silt Zone in Smith Creek Cave is of approximately 12 000 to 22 000 yr B.P. or even >30 000 yr B.P., then many of the lizards and snakes presently inhabiting the eastern Great Basin are not post-Pleistocene invaders. The important fact is that desert elements in the modern fauna were already in the Great Basin prior to the end of the late Wisconsinan. These results call for reconsideration of current biogeographical hypotheses on the evolution of the Great Basin Desert fauna.

At some time in the late Pleistocene and early Holocene, some of the amphibians, reptiles, and mammals found in the Snake Range and Snake Valley either adjusted their distributions or became extinct. Martin (1967) has previously expressed his model that Early Man exterminated the megafauna of North America. The amphibians, reptiles, and small mammals adapted individually to the climatic changes, however minor or major, of the late Pleistocene and Holocene.

Brown (1971, 1978) and Grayson (1981, *in press a, b*) have theorized that local extirpations in the Great Basin of an assemblage of small mammals on a mountain range are related to the size of the animal population and the mass of the mountain. In the case of the Snake Range (emphasizing Smith Creek Canyon) certain animal species became extirpated (*Sceloporus magister*, *Phenacomys* cf. *intermedius*, *Ochotona* cf. *princeps*, and others) while additional species developed relictual populations, inhabitants of a boreal island in a sea of sagebrush (e.g., *Lampropeltis pyromelana* and *Marmota flaviventris*). The smaller mammals, at least *Ochotona* and *Phenacomys*, lingered on into the early Holocene (Grayson 1981; this report). The *Ochotona* cf. *princeps* remains reported here indicate that suitable habitat and climate occurred in the Snake Valley at least until ca. 12 000 yr B.P. and in Smith Creek Canyon until ca. 6500 yr B.P. (Thompson and Mead 1982). Similar extralocal occurrences of *Ochotona* are documented as late as 7000 yr B.P. in eastern Oregon (Grayson 1981, *in press*). Grayson has argued that the timing of extinction of these relictual small mammal (and possibly some amphibian and reptile) populations was in large part determined by the size and distribution of habitat islands and by the size of the species population on the given habitat island. It is also possible that the mid-Holocene period of warmer-than-present temperatures, seen in the elevational raising of upper treeline on the Snake Range and elsewhere in the Great Basin (LaMarche 1973, LaMarche and Mooney 1972) may have reduced the size of montane habitat islands and accelerated the rate of extinction of animal populations.

The faunal account presented here is the first detailed account of amphibians and reptiles from late Pleistocene and early Holocene age deposits in the interior Great Basin; in addition, the assemblage has provided additional data on mammalian species. The *Phenacomys* cf. *intermedius* reported here is the first late Pleistocene record of the genus in the Great Basin. Because some of the fauna (especially *Ochotona*) was recovered from packrat middens, it is associated directly with a reconstruction of the local flora based on plant macrofossils. To our knowledge, similar plant and animal associations have not been pursued in this detail for the Great Basin.

The research in Smith Creek Canyon over the last 50 years has illustrated the wealth of information, mainly faunal, available in dry cave deposits of the Great Basin. With the recent surge of packrat midden analyses in Smith Creek Canyon, a whole new aspect of late Pleistocene and Holocene community reconstruction has emerged. Faunal assemblages can now be found in and associated temporally with the wealth of flora data recoverable from packrat middens.

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